PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-037180
(43)Date of publication of application : 06.02.1996

(51)Int.CI. H01L 21/3065
C23F 4/00

(21)Application number : 07-048395
(22)Date of filing : 08.03.1995

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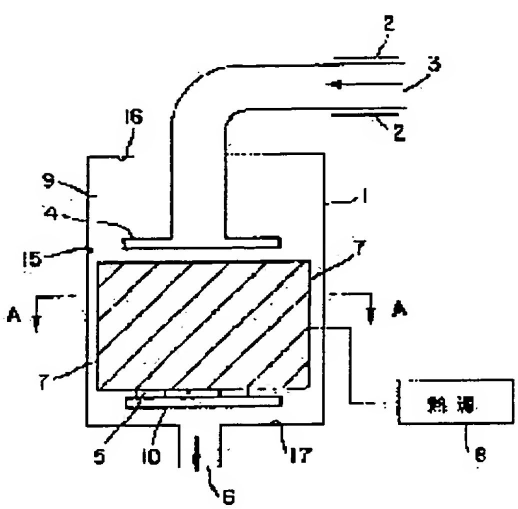
(30)Priority
Priority number : 94 208158 Priority date : 08.03.1994 Priority country : US

(54) HOT WALL REACTIVE ION ETCHING CONTROLLING TEMPERATURE FOR OBTAINING STABILITY OF STEP



(57)Abstract:
PURPOSE: To prevent an unfavorable film from being adhered to an inner wall of a device by a method wherein an etching chamber having adhesion-resistance means, a holder of the device to be etched and adhesion-resistance surface means are heated at a temperature in a specific range.
CONSTITUTION: In a downstream type plasma etching device 1, an electrode 2 is provided at a gas inlet 3, and gas containing fluorine is supplied from the inlet 3 and is passed through the electrode 2, and the gas is converted into a plasma. Gas is diffused in an etching chamber 9 from a nozzle 4. Further, a substrate 5 to be etched is held by a holder 10 and a liner 7 for protecting wall faces 15, 16, 17 of the etching chamber 9 is provided, and the liner 7 is heated at a temperature of 100 to 600°C by a heat source 8. Thereby, it is possible to reduce remarkably adhesion of fluorocarbon films to the wall faces 15, 16, 17 in the etching chamber 9.

CLAIMS

[Claim(s)]

[Claim 1] The plasma-etching device which prevents in the adhesion of the coat which is not desirable possessing the etching chamber which has an adhesion-proof surface means, a means which is in the above-mentioned etching chamber and was surrounded by the above-mentioned adhesion-proof surface means hold a device, and the means for heating the above-mentioned adhesion-proof surface means in temperature of 100,degrees C thru/or 600 degrees C in order to prevent the coat formation in the above-mentioned etching chamber.

[Claim 2] Equipment according to claim 1 with which the above-mentioned adhesion-proof surface means is characterized by not blocking a plasma style.

[Claim 3] Equipment according to claim 1 characterized by heating the above-mentioned adhesion-proof surface means at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.

[Claim 4] Equipment according to claim 1 characterized by the above-mentioned adhesion-proof surface means consisting of a side attachment wall of an etching chamber.

[Claim 5] Equipment according to claim 1 characterized by the above-mentioned adhesion-proof surface means consisting of a liner in an etching chamber.

[Claim 6] Equipment according to claim 1 with which the above-mentioned adhesion-proof surface means is characterized by being placed on the side attachment wall of an etching chamber.

[Claim 7] Equipment according to claim 1 characterized by carrying out coating of the above-mentioned adhesion-proof surface means with an ingredient with the low erosion ratio in the inside of a plasma style.

[Claim 8] Equipment according to claim 7 characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof surface means becomes from aluminum 2O3, Y2O3, and Sc2O3.

[Claim 9] Equipment according to claim 1 characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of a metal and a dielectric.

[Claim 10] Equipment according to claim 9 characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of stainless steel, a ceramic, a quartz, and aluminum.

[Claim 11] Equipment according to claim 1 characterized by the above-mentioned adhesion-proof surface means facing the plasma generated in an etching chamber.

[Claim 12] Equipment according to claim 1 characterized by an etching chamber being one of the oxide reactive-ion-etching chamber which uses fluoro carbon, and dry etching chambers.

[Claim 13] Equipment according to claim 1 characterized by having the source of the high density plasma which has resonant frequency bias.

[Claim 14] Equipment of claim 13 with which the source of the high density plasma is characterized by being one of the electronic resonance plasma and joint resonant frequency plasma.

[Claim 15] How to have the process which prevents that place an adhesion-proof side into the cavity of an etching chamber, heat the above-mentioned adhesion-proof front face in an etching chamber in temperature of 100 degrees C thru/or 600 degrees C in the approach of preventing that the coat which is not desirable adheres in an etching

chamber, and a coat forms in the above-mentioned etching chamber during etching.
[Claim 16] The approach according to claim 15 characterized by heating the above-mentioned adhesion-proof front face at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.
[Claim 17] The approach according to claim 15 that the above-mentioned adhesion-proof front face is characterized by being the side attachment wall of an etching chamber.
[Claim 18] The approach according to claim 15 which the above-mentioned etching chamber generates the plasma and is characterized by carrying out coating of the above-mentioned adhesion-proof front face with an ingredient with the low erosion ratio in the inside of a plasma style.
[Claim 19] The approach according to claim 18 characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof front face becomes from aluminum 2O3, Y2O3, and Sc2O3.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to formation prevention of the coat which is not [on the etching chamber front face especially exposed to the plasma during etching of a semiconductor device] desirable about manufacture of a semi-conductor.
[0002]
[Description of the Prior Art] In order to improve the fault of the etching chamber by the Prior art, the approach and device of etching of a semiconductor device are offered.
[0003] A plasma dry type dirty reactor is a vacuum chamber in which the electric plasma is formed, in order to etch a semiconductor wafer. Etching is usually performed through a photoresist mask.
[0004] A dry etching technique may be called reactive ion etching or plasma etching. The dry etching device by the Prior art forms the plasma by pouring precursor gas into the area in which RF electric field are formed. Precursor gas is easy to contain the gas containing a fluorine, CHF3 or CF4. [for example,]
[0005] RF electric field can be generated with 2 or three internal electrodes linked to an RF generator, an external electrode, or a coil. Precursor gas changes with high-frequency excitation to the plasma which generates ion and a reactant radical. The generated reactant radical is diffused on the front face etched, and etching is performed chemically. A semiconductor device is exposed to the activity ion of the plasma by the ion using method. Ion is turned to a semiconductor device, ion collides with a substrate and a part of front face of a substrate is removed by etching here. The ion using method is related to both chemistry and physical etching.
[0006] Between etching processes, a fluoro carbon (fluorocarbon) coat adheres to the wall surface of an etching chamber. While the impedance of a device changes and time amount passes by adhesion of a fluoro carbon coat, the auto-bias electrical potential difference of an etching chamber decreases. The operating characteristic of an etching device changes by this, and an etching process is affected. Furthermore, the fluoro carbon coat adhering to the wall surface of an etching chamber exfoliates, and it becomes a source of a particle in an etching chamber.

[0007] Adhesion of the fluoro carbon coat to the wall surface of an etching chamber was processed by carrying out re-conditioning of the etching chamber, after washing an etching chamber conventionally using O2 plasma. Washing and the seasoning process of a chamber may require the time amount to 30% of the total operating hour of a device.
[0008] it was what offers the approach and (or) device for removing a part of problem produced by adhesion of the fluoro carbon coat to the front face of an etching chamber in the design by the Prior art. For example, in one sort of devices, the substrate which should be etched is placed into an etching chamber, and while being heated by the temperature whose chamber is about 80 degrees C, it is cooled. Surface heating is performed by supplying hot water to the pipe attached in the front face of a dry etching device. While a substrate is etched, this is performed in order to decrease that a polymer coat pastes the wall surface of an etching device.
[0009] however, this approach and (or) device decrease slightly the sticking rate of the fluoro carbon coat to the wall of a chamber -- it is not alike too much. Furthermore, though 10 thru/or 20% sticking rate are selectively decreased by heating at 80 degrees C when using a high density plasma device into an etching process, an etching chamber must still be washed frequently.
[0010]
[Problem(s) to be Solved by the Invention] The object of this invention is to offer the approach and device which prevent that the coat which is not desirable adheres to the wall of a device between etching processes and which etch a semiconductor device.
[0011]
[Means for Solving the Problem] The etching device of this invention has the etching chamber which has an adhesion-proof front face, the holder of the device which should be etched, and the heater which heats an adhesion-proof front face in temperature of 100 degrees C thru/or 600 degrees C, and prevents coat formation on a chamber wall surface. Further, this etching device may surround a holder and may have the adhesion-proof front face which does not block the plasma moreover used for etching of a substrate.
[0012]
[Example] The downstream mold plasma etching device 1 is shown in drawing 1 . This downstream mold plasma etching device 1 has the electrode 2 for plasma generating which surrounds a gas inlet 3. A gas inlet 3 supplies the gas containing fluorines, such as CF4 and CHF3. Passage of an electrode 2 of the gas containing a fluorine changes gas into the plasma. A nozzle 4 diffuses gas in the etching chamber 9. In the etching chamber 9, the holder 10 holding the substrate 5 etched is in a nozzle 4 and an opposite hand. The outlet 6 is also formed in order to exhaust the plasma.
[0013] The liner 7 for protecting the wall surfaces 15, 16, and 17 of the etching chamber 9 which surrounds a nozzle 4 and a holder 10 is in the etching chamber 9. A liner 7 is the ingredient of etching-proof nature which can be heated. The liner 7 is connected to a heat source 8 in order to heat a liner 7 in an etching process. The source of electric heat or the electric bulb for heating for heating a liner 7 using resistance heating is sufficient as a heat source 8. As an alternate method, a heat source 8 may contain the heated liquid which circulates through the inside of a liner 7, or a perimeter.
[0014] Instead of establishing an external heat source, it is also possible by establishing a heat source into a liner to remove the need for another heat source.
[0015] A heat source 8 has the control element which controls and holds the temperature of a liner 7. For example, since the temperature of a liner 7 is measured,

probes (not shown), such as a thermocouple, can be placed near the liner 7 in the etching chamber 9. In order that the control element within the external heat source 8 may hold a liner 7 to expected temperature, the heat which a liner 7 is supplied in response to carrier beam temperature data from a thermocouple, or a liner 7 generates is adjusted.

[0016] using feedback devices, such as a control element, and holding a liner 7 to specific temperature -- etching -- in process -- it is especially important. The plasma generated during etching serves as a heat source which heats a liner 7 further. In order to offset the heat which the plasma generates, a control element decreases the heat which a heat source 8 supplies to a liner 7. Thus, feedback control for maintaining the temperature of a liner 7 is performed.

[0017] many the approaches and (or) devices for controlling and maintaining the temperature of a liner 7 combining a heat source 8 can be considered. In order to maintain the expected temperature for example, in a chamber, combination hand control, automatic or hand control, and automatic etc. is included in these. a control element is performed by the hardware and (or) software of a computer.

[0018] Drawing 2 shows the cross section which met the line AA of drawing 1 . In this drawing, in order to make it intelligible, the substrate 5 is omitted.

[0019] The holder 10 surrounded by the liner 7 which shields the wall surfaces 15, 16, and 17 of the etching chamber 9 is shown in drawing 2 . Thus, it prevents that a liner 7 is exposed to the by-product of the plasma from which wall surfaces 15, 16, and 17 become the cause of making a coat adhering on wall surfaces 15, 16, and 17, and an etching process.

[0020] The liner 7 is shown in drawing 2 also as one continuous front face placed into the etching chamber 9. However, a liner 7 may be formed from the components according to two or more individuals placed into the etching chamber 9, in order to protect the front face of an etching chamber. In order to etch a substrate 5, unless the plasma formed in the etching chamber 9 is blocked, as for a liner 7, it is desirable to protect as widely as possible the area of wall surfaces 15, 16, and 17. For example, it is made for a liner 7 not to block the straight line which ties the generated plasma and a substrate 5.

[0021] Furthermore, by making a liner 7 into the whole, a liner 7 can establish one heat source combined with the liner which has the components according to individual, or two or more heat sources 8 according to an individual in order to heat as a subset group.

[0022] During actuation, a substrate 5 is placed on the substrate holder 10 of the etching chamber 9. A liner 7 heats a liner 7 using the heater 8 heated to the temperature of about 300 degrees C for etching processing of fluoro carbon oxide. Temperature can be made into 100 thru/or the range of 600 degrees C although the temperature of about 300 degrees C is desirable. This is for adhesion of the fluoro carbon to a liner 7 top to decrease notably in this range.

[0023] After a liner 7 reaches expected temperature, it starts by passing the electrode 2 made to generate the RF electric field which excite gas and are changed to the plasma. Between etching processes, a liner 7 is maintained at an elevated temperature and blocks remarkably adhesion of the wall surfaces 15, 16, and 17 of the etching chamber 9 and the fluoro carbon to a liner 7.

[0024] A control element supervises and maintains the temperature of a liner 7 by supervising the temperature data obtained from a probe. In response to the temperature data from a probe, the heating value supplied to a liner 7 from a heat source 8 is adjusted, and a liner 7 is maintained at expected temperature.

[0025] By using the liner 7 heated at 300 degrees C, the width of face of the process window of the plasma etching device 1 becomes large. The thing of a series of constraint in case, as for a process window, a plasma etching device operates is said. Although there is power which can operate the time amount used for etching of a chamber, the class of usable mixed gas, and a device in these constraint, it is not limited to these.
[0026] By using a liner 7, the stop time for washing of a device is shortened and the whole time amount which can be used for etching of a plasma etching device increases. This is because adhesion of the fluoro carbon coat to the wall surfaces 15, 16, and 17 of an etching chamber can be decreased remarkably by using the liner heated at 300 degrees C. In connection with this, the stop time of the device for washing of an etching chamber can be decreased.
[0027] By the approach by the Prior art, after removing the coat adhering to the wall surface of an etching chamber using O2 plasma, it was carrying out re-conditioning of the etching chamber. 30% of all the operation time of a device is needed for this process. However, the stop time of the plasma etching device 1 is shortened by using the liner 7 of this example.
[0028] Furthermore, the fluoro carbon coat which is not used can usually be used for etching with a liner 7. For example, between etching of oxide, since the selectivity of etching of a semiconductor device is high, etching gas, such as C2F4, C2F6, C2F8, and C2HF5, can be used. However, these gas has the problem which is not desirable that the fluoro carbon coat of a large quantity adheres, on the front face which the etching chamber exposed. Since this problem is solved, it can use together with the liner 7 which controls generation of a fluoro carbon coat.
[0029] Moreover, one etching chamber can be operated with the power level which excitation of gas produces on high energy level and which increased. Although an etch rate becomes high so that power level is made high, adhesion of a fluoro carbon coat also increases. However, adhesion of a fluoro carbon coat decreases remarkably by using the liner heated at 300 degrees C.
[0030] Furthermore, since adhesion of a fluoro carbon coat is substantially blocked in this etching process, the instability of a proper decreases at the etching process which uses fluoro carbon gas. The generation rate of the fluoro carbon coat on the wall surface of an etching chamber does not make active jamming of etching increase during etching in order to decrease substantially.
[0031] In the alternative example, the wall surface of the etching chamber 9 shown in drawing 1 can be heated to an elevated temperature, without arranging the separated liner front face. Heating of the etching chamber 9 can be performed by the same approach as the 1st example which uses a liner 7 into the etching chamber 9. In this example, the same desirable effectiveness as the case where a liner 7 is heated is acquired by heating the wall surface of a chamber at 300 degrees C. Moreover, a liner 7 can also be formed on wall surfaces 15, 16, and 17.
[0032] The plasma etching device which can use the heated liner is not limited to a downstream etching device, for example, various kinds of etching devices, such as a juxtaposition electrode reaction device, a barrel etching device, a cylinder batch type dirty reaction device, and a magnetron ion etching device, can be used for it. Furthermore, the source of the high density plasma can also be used with resonant frequency biasing. The high density plasma can also be made into for example, the electronic resonance plasma or the joint resonant frequency plasma.
[0033] The 2nd example of this invention is shown in drawing 3 thru/or drawing 5 . The parallel plate electrode etching device 31 has the electrode 36 which functions

also as a substrate holder. The 2nd electrode 33 is grounded and is also the up wall surface of the etching chamber 38. The plasma is generated among the electrodes 33 and 36 on a substrate 35 in an etching process.
[0034] The liner which consists of components 37 and 39 is prepared in the etching chamber 38, and adhesion of the fluoro carbon coat of the wall surfaces 40 and 41 which the etching chamber 38 exposed is prevented.
[0035] During operation, the example shown in drawing 3 thru/or drawing 5 prevents formation of a fluoro carbon coat like the 1st example shown in drawing 1 . This example uses an external heat source (not shown) for heating of liners 37 and 39 like the 1st example. The front face of a liner is heated by 300 degrees C before etching process initiation.
[0036] the wall surface of the liner and (or) etching chamber of the 1st and 2nd examples can be manufactured with various kinds of ingredients, such as a ceramic, aluminum, steel, and (or) a quartz. Since aluminum is easy to machine, it is a desirable ingredient. However, aluminum has the plasma and reactivity which are generated from a part of precursor gas used into an etching process. Then, to the plasma, since an aluminum oxide is inactive, it uses the aluminum oxide prepared in the liner or the wall surface of a chamber, or its coating.
[0037] the ingredient used since a liner and (or) the wall surface of a chamber are constituted -- in addition, a liner front face and (or) the wall surface protective coating of a chamber can be applied. For example, aluminum 2O3, Sc2O3, or Y2O3 can be used as an exposed surface coating ingredient. Since it has etching-proof nature to the plasma generated in an etching process, these ingredients are chosen.
[0038] selection of the above-mentioned ingredient and (or) coating -- etching -- it carries out based on an ingredient and (or) coating with the capacity to prevent generation of the particle which makes the front face or ingredient in the ingredient which is equal to the chemical corrosion by the radical generated in the plasma by excitation of precursor gas in process, coating, and an etching chamber exfoliate.
[0039] For example, since an aluminum oxide is inactive chemically to the fluoro carbon used at some etching processes, it is an important coating ingredient. Furthermore, it is a good ingredient for coating the aluminum used for manufacturing an etching chamber in many cases.
[0040] Without blocking etching of a semiconductor device, the liner should be prepared in the etching chamber, in order to shield the great portion of surface area of an etching chamber from formation of a fluoro carbon coat. So, a liner is constituted from the 2nd example shown in drawing 3 thru/or drawing 5 by the components according to some individuals in order to cover the front face of an etching chamber to max certainly, without blocking the plasma to generate. As shown in the 1st example of drawing 1 , in order to cover the front face of an etching chamber as an alternate method, one continuous liner is suitable.
[0041] Although it is not necessary to cover the whole front face of an etching chamber with a liner, in order to prevent adhesion of a fluoro carbon coat, it is desirable to shield the largest possible range.
[0042] Drawing 6 shows the result which heated the front face prepared in the etching chamber to the elevated temperature, and was obtained. The peak voltage in pressure the torr of 100mm, and an etching process is etched for a silicon substrate by abbreviation-580V. It was used for plasma generating of three kinds of gas of CHF3 [CHF3 (100%) and]/H2 (30%) and CHF3/H2 (50%) for the comparison. These three kinds of gas is used for drawing, and it measures the sticking rate of a fluoro carbon coat. As it saw by these three kinds of gas, most sticking rates of the fluoro carbon

coat in the heated front face were 0 at 300 degrees C to about 10nm being a part for /in the room temperature. Furthermore, at less than 100 degrees C, if reduction in a sticking rate exceeds it slightly to 100 degrees C or more 300 degrees C of a certain thing, a sticking rate will decrease considerably.

[0043] As a conclusion, the following matters are indicated about the configuration of this invention.

[0044] (1) The plasma-etching device which prevents in the adhesion of the coat which is not desirable possessing the etching chamber which has an adhesion-proof surface means, a means which is in the above-mentioned etching chamber and were surrounded by the above-mentioned adhesion-proof surface means hold a device, and the means for heating the above-mentioned adhesion-proof surface means in temperature of 100 degrees C thru/or 600 degrees C in order to prevent the coat formation in the above-mentioned etching chamber.

(2) Equipment given in the above (1) whose above-mentioned adhesion-proof surface means is characterized by not blocking a plasma style.

(3) Equipment given in the above (1) characterized by heating the above-mentioned adhesion-proof surface means at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.

(4) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of a side attachment wall of an etching chamber.

(5) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of a liner in an etching chamber.

(6) Equipment given in the above (1) whose above-mentioned adhesion-proof surface means is characterized by being placed on the side attachment wall of an etching chamber.

(7) Equipment given in the above (1) characterized by carrying out coating of the above-mentioned adhesion-proof surface means with an ingredient with the low erosion ratio in the inside of a plasma style.

(8) Equipment given in the above (7) characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof surface means becomes from aluminum 2O3, Y2O3, and Sc2O3.

(9) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of a metal and a dielectric.

(10) Equipment given in the above (9) characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of stainless steel, a ceramic, a quartz, and aluminum.

(11) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means facing the plasma generated in an etching chamber.

(12) Equipment given in the above (1) characterized by an etching chamber being one of the oxide reactive-ion-etching chamber which uses fluoro carbon, and dry etching chambers.

(13) Equipment given in the above (1) characterized by having the source of the high density plasma which has resonant frequency bias.

(14) Equipment of the above (13) with which the source of the high density plasma is characterized by being one of the electronic resonance plasma and joint resonant frequency plasma.

(15) How to have the process which prevents that place an adhesion-proof side into the cavity of an etching chamber, heat the above-mentioned adhesion-proof front face in an etching chamber in temperature of 100 degrees C thru/or 600 degrees C in the

approach of preventing that the coat which is not desirable adheres in an etching chamber, and a coat forms in the above-mentioned etching chamber during etching.
(16) An approach given in the above (15) characterized by heating the above-mentioned adhesion-proof front face at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.
(17) An approach given in the above (15) whose above-mentioned adhesion-proof front face is characterized by being the side attachment wall of an etching chamber.
(18) An approach given in the above (15) which the above-mentioned etching chamber generates the plasma and is characterized by carrying out coating of the above-mentioned adhesion-proof front face with an ingredient with the low erosion ratio in the inside of a plasma style.
(19) An approach given in the above (18) characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof front face becomes from aluminum 2O3, Y2O3, and Sc2O3.
[Effect of the Invention]

TECHNICAL FIELD

[Industrial Application] This invention relates to formation prevention of the coat which is not [on the etching chamber front face especially exposed to the plasma during etching of a semiconductor device] desirable about manufacture of a semi-conductor.

PRIOR ART

[Description of the Prior Art] In order to improve the fault of the etching chamber by the Prior art, the approach and device of etching of a semiconductor device are offered.
[0003] A plasma dry type dirty reactor is a vacuum chamber in which the electric plasma is formed, in order to etch a semiconductor wafer. Etching is usually performed through a photoresist mask.
[0004] A dry etching technique may be called reactive ion etching or plasma etching. The dry etching device by the Prior art forms the plasma by pouring precursor gas into the area in which RF electric field are formed. Precursor gas is easy to contain the gas containing a fluorine, CHF3 or CF4. [for example,]
[0005] RF electric field can be generated with 2 or three internal electrodes linked to an RF generator, an external electrode, or a coil. Precursor gas changes with high-frequency excitation to the plasma which generates ion and a reactant radical. The generated reactant radical is diffused on the front face etched, and etching is performed chemically. A semiconductor device is exposed to the activity ion of the plasma by the ion using method. Ion is turned to a semiconductor device, ion collides with a substrate and a part of front face of a substrate is removed by etching here. The ion using method is related to both chemistry and physical etching.
[0006] Between etching processes, a fluoro carbon (fluorocarbon) coat adheres to the wall surface of an etching chamber. While the impedance of a device changes and time amount passes by adhesion of a fluoro carbon coat, the auto-bias electrical potential difference of an etching chamber decreases. The operating characteristic of an etching device changes by this, and an etching process is affected. Furthermore, the

fluoro carbon coat adhering to the wall surface of an etching chamber exfoliates, and it becomes a source of a particle in an etching chamber.

[0007] Adhesion of the fluoro carbon coat to the wall surface of an etching chamber was processed by carrying out re-conditioning of the etching chamber, after washing an etching chamber conventionally using O2 plasma. Washing and the seasoning process of a chamber may require the time amount to 30% of the total operating hour of a device.

[0008] it was what offers the approach and (or) device for removing a part of problem produced by adhesion of the fluoro carbon coat to the front face of an etching chamber in the design by the Prior art. For example, in one sort of devices, the substrate which should be etched is placed into an etching chamber, and while being heated by the temperature whose chamber is about 80 degrees C, it is cooled. Surface heating is performed by supplying hot water to the pipe attached in the front face of a dry etching device. While a substrate is etched, this is performed in order to decrease that a polymer coat pastes the wall surface of an etching device.

[0009] however, this approach and (or) device decrease slightly the sticking rate of the fluoro carbon coat to the wall of a chamber -- it is not alike too much. Furthermore, though 10 thru/or 20% sticking rate are selectively decreased by heating at 80 degrees C when using a high density plasma device into an etching process, an etching chamber must still be washed frequently.

EFFECT OF THE INVENTION

[Effect of the Invention]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The object of this invention is to offer the approach and device which prevent that the coat which is not desirable adheres to the wall of a device between etching processes and which etch a semiconductor device.

MEANS

[Means for Solving the Problem] The etching device of this invention has the etching chamber which has an adhesion-proof front face, the holder of the device which should be etched, and the heater which heats an adhesion-proof front face in temperature of 100 degrees C thru/or 600 degrees C, and prevents coat formation on a chamber wall surface. Further, this etching device may surround a holder and may have the adhesion-proof front face which does not block the plasma moreover used for etching of a substrate.

EXAMPLE

[Example] The downstream mold plasma etching device 1 is shown in <u>drawing 1</u> . This downstream mold plasma etching device 1 has the electrode 2 for plasma generating which surrounds a gas inlet 3. A gas inlet 3 supplies the gas containing

fluorines, such as CF4 and CHF3. Passage of an electrode 2 of the gas containing a fluorine changes gas into the plasma. A nozzle 4 diffuses gas in the etching chamber 9. In the etching chamber 9, the holder 10 holding the substrate 5 etched is in a nozzle 4 and an opposite hand. The outlet 6 is also formed in order to exhaust the plasma.

[0013] The liner 7 for protecting the wall surfaces 15, 16, and 17 of the etching chamber 9 which surrounds a nozzle 4 and a holder 10 is in the etching chamber 9. A liner 7 is the ingredient of etching-proof nature which can be heated. The liner 7 is connected to a heat source 8 in order to heat a liner 7 in an etching process. The source of electric heat or the electric bulb for heating for heating a liner 7 using resistance heating is sufficient as a heat source 8. As an alternate method, a heat source 8 may contain the heated liquid which circulates through the inside of a liner 7, or a perimeter.

[0014] Instead of establishing an external heat source, it is also possible by establishing a heat source into a liner to remove the need for another heat source.

[0015] A heat source 8 has the control element which controls and holds the temperature of a liner 7. For example, since the temperature of a liner 7 is measured, probes (not shown), such as a thermocouple, can be placed near the liner 7 in the etching chamber 9. In order that the control element within the external heat source 8 may hold a liner 7 to expected temperature, the heat which a liner 7 is supplied in response to carrier beam temperature data from a thermocouple, or a liner 7 generates is adjusted.

[0016] using feedback devices, such as a control element, and holding a liner 7 to specific temperature -- etching -- in process -- it is especially important. The plasma generated during etching serves as a heat source which heats a liner 7 further. In order to offset the heat which the plasma generates, a control element decreases the heat which a heat source 8 supplies to a liner 7. Thus, feedback control for maintaining the temperature of a liner 7 is performed.

[0017] many the approaches and (or) devices for controlling and maintaining the temperature of a liner 7 combining a heat source 8 can be considered. In order to maintain the expected temperature for example, in a chamber, combination hand control, automatic or hand control, and automatic etc. is included in these. a control element is performed by the hardware and (or) software of a computer.

[0018] Drawing 2 shows the cross section which met the line AA of drawing 1 . In this drawing, in order to make it intelligible, the substrate 5 is omitted.

[0019] The holder 10 surrounded by the liner 7 which shields the wall surfaces 15, 16, and 17 of the etching chamber 9 is shown in drawing 2 . Thus, it prevents that a liner 7 is exposed to the by-product of the plasma from which wall surfaces 15, 16, and 17 become the cause of making a coat adhering on wall surfaces 15, 16, and 17, and an etching process.

[0020] The liner 7 is shown in drawing 2 also as one continuous front face placed into the etching chamber 9. However, a liner 7 may be formed from the components according to two or more individuals placed into the etching chamber 9, in order to protect the front face of an etching chamber. In order to etch a substrate 5, unless the plasma formed in the etching chamber 9 is blocked, as for a liner 7, it is desirable to protect as widely as possible the area of wall surfaces 15, 16, and 17. For example, it is made for a liner 7 not to block the straight line which ties the generated plasma and a substrate 5.

[0021] Furthermore, by making a liner 7 into the whole, a liner 7 can establish one heat source combined with the liner which has the components according to individual, or two or more heat sources 8 according to an individual in order to heat as

a subset group.
[0022] During actuation, a substrate 5 is placed on the substrate holder 10 of the etching chamber 9. A liner 7 heats a liner 7 using the heater 8 heated to the temperature of about 300 degrees C for etching processing of fluoro carbon oxide. Temperature can be made into 100 thru/or the range of 600 degrees C although the temperature of about 300 degrees C is desirable. This is for adhesion of the fluoro carbon to a liner 7 top to decrease notably in this range.
[0023] After a liner 7 reaches expected temperature, it starts by passing the electrode 2 made to generate the RF electric field which excite gas and are changed to the plasma. Between etching processes, a liner 7 is maintained at an elevated temperature and blocks remarkably adhesion of the wall surfaces 15, 16, and 17 of the etching chamber 9 and the fluoro carbon to a liner 7.
[0024] A control element supervises and maintains the temperature of a liner 7 by supervising the temperature data obtained from a probe. In response to the temperature data from a probe, the heating value supplied to a liner 7 from a heat source 8 is adjusted, and a liner 7 is maintained at expected temperature.
[0025] By using the liner 7 heated at 300 degrees C, the width of face of the process window of the plasma etching device 1 becomes large. The thing of a series of constraint in case, as for a process window, a plasma etching device operates is said. Although there is power which can operate the time amount used for etching of a chamber, the class of usable mixed gas, and a device in these constraint, it is not limited to these.
[0026] By using a liner 7, the stop time for washing of a device is shortened and the whole time amount which can be used for etching of a plasma etching device increases. This is because adhesion of the fluoro carbon coat to the wall surfaces 15, 16, and 17 of an etching chamber can be decreased remarkably by using the liner heated at 300 degrees C. In connection with this, the stop time of the device for washing of an etching chamber can be decreased.
[0027] By the approach by the Prior art, after removing the coat adhering to the wall surface of an etching chamber using O2 plasma, it was carrying out re-conditioning of the etching chamber. 30% of all the operation time of a device is needed for this process. However, the stop time of the plasma etching device 1 is shortened by using the liner 7 of this example.
[0028] Furthermore, the fluoro carbon coat which is not used can usually be used for etching with a liner 7. For example, between etching of oxide, since the selectivity of etching of a semiconductor device is high, etching gas, such as C2F4, C2F6, C2F8, and C2HF5, can be used. However, these gas has the problem which is not desirable that the fluoro carbon coat of a large quantity adheres, on the front face which the etching chamber exposed. Since this problem is solved, it can use together with the liner 7 which controls generation of a fluoro carbon coat.
[0029] Moreover, one etching chamber can be operated with the power level which excitation of gas produces on high energy level and which increased. Although an etch rate becomes high so that power level is made high, adhesion of a fluoro carbon coat also increases. However, adhesion of a fluoro carbon coat decreases remarkably by using the liner heated at 300 degrees C.
[0030] Furthermore, since adhesion of a fluoro carbon coat is substantially blocked in this etching process, the instability of a proper decreases at the etching process which uses fluoro carbon gas. The generation rate of the fluoro carbon coat on the wall surface of an etching chamber does not make active jamming of etching increase during etching in order to decrease substantially.

[0031] In the alternative example, the wall surface of the etching chamber 9 shown in drawing 1 can be heated to an elevated temperature, without arranging the separated liner front face. Heating of the etching chamber 9 can be performed by the same approach as the 1st example which uses a liner 7 into the etching chamber 9. In this example, the same desirable effectiveness as the case where a liner 7 is heated is acquired by heating the wall surface of a chamber at 300 degrees C. Moreover, a liner 7 can also be formed on wall surfaces 15, 16, and 17.
[0032] The plasma etching device which can use the heated liner is not limited to a downstream etching device, for example, various kinds of etching devices, such as a juxtaposition electrode reaction device, a barrel etching device, a cylinder batch type dirty reaction device, and a magnetron ion etching device, can be used for it. Furthermore, the source of the high density plasma can also be used with resonant frequency biasing. The high density plasma can also be made into for example, the electronic resonance plasma or the joint resonant frequency plasma.
[0033] The 2nd example of this invention is shown in drawing 3 thru/or drawing 5 . The parallel plate electrode etching device 31 has the electrode 36 which functions also as a substrate holder. The 2nd electrode 33 is grounded and is also the up wall surface of the etching chamber 38. The plasma is generated among the electrodes 33 and 36 on a substrate 35 in an etching process.
[0034] The liner which consists of components 37 and 39 is prepared in the etching chamber 38, and adhesion of the fluoro carbon coat of the wall surfaces 40 and 41 which the etching chamber 38 exposed is prevented.
[0035] During operation, the example shown in drawing 3 thru/or drawing 5 prevents formation of a fluoro carbon coat like the 1st example shown in drawing 1 . This example uses an external heat source (not shown) for heating of liners 37 and 39 like the 1st example. The front face of a liner is heated by 300 degrees C before etching process initiation.
[0036] the wall surface of the liner and (or) etching chamber of the 1st and 2nd examples can be manufactured with various kinds of ingredients, such as a ceramic, aluminum, steel, and (or) a quartz. Since aluminum is easy to machine, it is a desirable ingredient. However, aluminum has the plasma and reactivity which are generated from a part of precursor gas used into an etching process. Then, to the plasma, since an aluminum oxide is inactive, it uses the aluminum oxide prepared in the liner or the wall surface of a chamber, or its coating.
[0037] the ingredient used since a liner and (or) the wall surface of a chamber are constituted -- in addition, a liner front face and (or) the wall surface protective coating of a chamber can be applied. For example, aluminum 2O3, $Sc2O3$, or $Y2O3$ can be used as an exposed surface coating ingredient. Since it has etching-proof nature to the plasma generated in an etching process, these ingredients are chosen.
[0038] selection of the above-mentioned ingredient and (or) coating -- etching -- it carries out based on an ingredient and (or) coating with the capacity to prevent generation of the particle which makes the front face or ingredient in the ingredient which is equal to the chemical corrosion by the radical generated in the plasma by excitation of precursor gas in process, coating, and an etching chamber exfoliate.
[0039] For example, since an aluminum oxide is inactive chemically to the fluoro carbon used at some etching processes, it is an important coating ingredient. Furthermore, it is a good ingredient for coating the aluminum used for manufacturing an etching chamber in many cases.
[0040] Without blocking etching of a semiconductor device, the liner should be prepared in the etching chamber, in order to shield the great portion of surface area of

an etching chamber from formation of a fluoro carbon coat. So, a liner is constituted from the 2nd example shown in drawing 3 thru/or drawing 5 by the components according to some individuals in order to cover the front face of an etching chamber to max certainly, without blocking the plasma to generate. As shown in the 1st example of drawing 1 , in order to cover the front face of an etching chamber as an alternate method, one continuous liner is suitable.

[0041] Although it is not necessary to cover the whole front face of an etching chamber with a liner, in order to prevent adhesion of a fluoro carbon coat, it is desirable to shield the largest possible range.

[0042] Drawing 6 shows the result which heated the front face prepared in the etching chamber to the elevated temperature, and was obtained. The peak voltage in pressure the torr of 100mm, and an etching process is etched for a silicon substrate by abbreviation-580V. It was used for plasma generating of three kinds of gas of CHF3 [CHF3 (100%) and]/H2 (30%) and CHF3/H2 (50%) for the comparison. These three kinds of gas is used for drawing, and it measures the sticking rate of a fluoro carbon coat. As it saw by these three kinds of gas, most sticking rates of the fluoro carbon coat in the heated front face were 0 at 300 degrees C to about 10nm being a part for /in the room temperature. Furthermore, at less than 100 degrees C, if reduction in a sticking rate exceeds it slightly to 100 degrees C or more 300 degrees C of a certain thing, a sticking rate will decrease considerably.

[0043] As a conclusion, the following matters are indicated about the configuration of this invention.

[0044] (1) The plasma-etching device which prevents in the adhesion of the coat which is not desirable possessing the etching chamber which has an adhesion-proof surface means, a means which is in the above-mentioned etching chamber and were surrounded by the above-mentioned adhesion-proof surface means hold a device, and the means for heating the above-mentioned adhesion-proof surface means in temperature of 100 degrees C thru/or 600 degrees C in order to prevent the coat formation in the above-mentioned etching chamber.

(2) Equipment given in the above (1) whose above-mentioned adhesion-proof surface means is characterized by not blocking a plasma style.

(3) Equipment given in the above (1) characterized by heating the above-mentioned adhesion-proof surface means at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.

(4) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of a side attachment wall of an etching chamber.

(5) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of a liner in an etching chamber.

(6) Equipment given in the above (1) whose above-mentioned adhesion-proof surface means is characterized by being placed on the side attachment wall of an etching chamber.

(7) Equipment given in the above (1) characterized by carrying out coating of the above-mentioned adhesion-proof surface means with an ingredient with the low erosion ratio in the inside of a plasma style.

(8) Equipment given in the above (7) characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof surface means becomes from aluminum 2O3, Y2O3, and Sc2O3.

(9) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of a metal and a dielectric.

(10) Equipment given in the above (9) characterized by the above-mentioned adhesion-proof surface means consisting of an ingredient chosen from the group who consists of stainless steel, a ceramic, a quartz, and aluminum.
(11) Equipment given in the above (1) characterized by the above-mentioned adhesion-proof surface means facing the plasma generated in an etching chamber.
(12) Equipment given in the above (1) characterized by an etching chamber being one of the oxide reactive-ion-etching chamber which uses fluoro carbon, and dry etching chambers.
(13) Equipment given in the above (1) characterized by having the source of the high density plasma which has resonant frequency bias.
(14) Equipment of the above (13) with which the source of the high density plasma is characterized by being one of the electronic resonance plasma and joint resonant frequency plasma.
(15) How to have the process which prevents that place an adhesion-proof side into the cavity of an etching chamber, heat the above-mentioned adhesion-proof front face in an etching chamber in temperature of 100 degrees C thru/or 600 degrees C in the approach of preventing that the coat which is not desirable adheres in an etching chamber, and a coat forms in the above-mentioned etching chamber during etching.
(16) An approach given in the above (15) characterized by heating the above-mentioned adhesion-proof front face at 200 degrees C thru/or 400 degrees C or 275 degrees C thru/or 325 degrees C, or about 300 degrees C.
(17) An approach given in the above (15) whose above-mentioned adhesion-proof front face is characterized by being the side attachment wall of an etching chamber.
(18) An approach given in the above (15) which the above-mentioned etching chamber generates the plasma and is characterized by carrying out coating of the above-mentioned adhesion-proof front face with an ingredient with the low erosion ratio in the inside of a plasma style.
(19) An approach given in the above (18) characterized by carrying out coating with the ingredient chosen from the group which the above-mentioned adhesion-proof front face becomes from aluminum 2O3, Y2O3, and Sc2O3.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the schematic drawing showing the 1st example of this invention.
[Drawing 2] It is the sectional view which met the line AA of the 1st example of this invention shown in drawing 1 .
[Drawing 3] It is the schematic drawing showing the 2nd example of this invention.
[Drawing 4] It is the sectional view which met the line AA of the 2nd example of this invention shown in drawing 3 .
[Drawing 5] It is the sectional view which met the line BB of the 2nd example of this invention shown in drawing 3 .
[Drawing 6] It is drawing showing the relation of the sticking rate and the temperature of a front face of the coat on the heating front face in the etching chamber at the time of using three kinds of etching gas.
[Description of Notations]
1 Plasma Etching Device
2 Electrode
3 Gas Inlet

4 Nozzle
5 Substrate
6 Plasma Outlet
7 Liner
8 Heat Source
9 Etching Chamber
10 Substrate Holder
15 Chamber Wall Surface
16 Chamber Wall Surface
17 Chamber Wall Surface